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REPORT AND RECOMMENDATIONS

of the
Eighth Meeting of the

FARM EQUIPMENT AND STRUCTURES RESEARCH ADVISORY COMMITTEE

Phoenix and Tucson, Arizona
January 21-25, 1963

Membership of the Farm Equipment and Structures Research Advisory
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PREFACE

The eighth meeting of the Farm Equipment and Structures Research Advisory Committee was held in Phoenix and Tucson, Arizona, January 21-25, 1963, with all members present. The principal source of information was the progress report of the Agricultural Engineering Research Division, ARS, dated October 15, 1962, and a supplement dated December 15, 1962, containing a report on pertinent work done by the Clothing and Housing Research Division, ARS; Farm Production Economics Division, ERS; and Soil and Water Conservation Research Division, ARS.

This was a joint meeting with the Soils, Water, and Fertilizer Research Advisory Committee. Also in attendance were two members of the National Agricultural Research Advisory Committee: Messrs. William Applebaum, marketing consultant of Belmont, Massachusetts, and E. F. Heacox, vice president, Weyerhaeuser Timber Company, Tacoma, Washington. On the first day a tour by both committees was made of the Salt River Valley Project in the Phoenix area. The second day, the Farm Equipment and Structures Committee made a tour to observe mechanized operations pertaining to beef, dairy, vegetable, fruit, and beekeeping operations which was arranged by the University of Arizona Agricultural Engineering Department. The third day both committees toured the Cotton Research Center and the U. S. Water Conservation Laboratory in Tempe, Arizona, and then held a joint meeting in the afternoon to discuss irrigation and drainage research.

The background information furnished by progress reports and observations of research was supplemented by oral reports and discussion with leaders of USDA research programs who were present at the meeting. This information indicated that 910 professional man-years of effort were being devoted to research in agricultural engineering in the following proportions: 144, USDA; 191, State Agricultural Experiment Stations; and an estimated 575 by industry. This effort is devoted to the application of engineering principles to agricultural production and rural living. In the modern age most agricultural activities involve the use of mechanical devices to perform the old, established activities such as tilling the soil, planting and harvesting of crops, and application of pesticides -- but present day scientists are looking to the future as they contemplate needs for food and fiber by an increasing population and are working on such developments as the use of electrical and electronic methods for sorting seeds, radiation treatment that will improve seed germination, automatic feeding of livestock, measurement of backfat thickness and size of the loin eye in animals by instrumentation without damage to the animal.

Additional copies of this report may be obtained from Max Hinds, executive secretary, Farm Equipment & Structures Research Advisory Committee, Office of Administrator, Agricultural Research Service, Wash. 25, D.C.

I. GENERAL COMMENTS

The Agricultural Engineering Research Division should be commended on the large percentage of research that is planned and carried out on an interdisciplinary basis. This sound direction should be strongly encouraged in all phases of activity.

The almost total shift from the use of human and animal energy to the use of mechanical energy places the need for engineering squarely in every activity of the agricultural industry. It is urged that consideration be given to placing engineering research in agriculture in a better position to more adequately meet research needs in this area.

The committee suggests that one of the greatest contributions that the Department research program can make is through research programs that are concerned with the idea of developing basic principles that will meet information needs in the years ahead. Every effort should be made to discourage efforts of the "brush fire" nature which are almost invariably of very limited value.

In the engineering area the committee feels that the research engineer should be encouraged to interpret the data available at the earliest possible time in order to make the best possible use of design criteria available to practicing design groups. In many cases it will be necessary to revise these interpretations when further data are available. However, the early value of results will tend to be of greater service rather than waiting until final results are available.

The committee recognized the need for publication of negative as well as positive results in order that research in function may increase with a minimum number of cases where unsuccessful techniques or procedures are repeated.

II. GENERAL RECOMMENDATIONS

Keep Research Program Up-to-date: Drop "well-worked" areas of activity where a large part of the benefits of research have been achieved so that work on problems with greater promise of returns can be initiated.

Cooperation with State Experiment Stations: Whenever possible work should be done in close cooperation with state experiment station personnel so that full benefits of program coordination can be derived with the dividend of training much needed research scientists. Centralized laboratories should be set up only if this is clearly the best way to accomplish the objectives, and then should be located near a land-grant university. Whenever the federal project fits into the objectives of a Regional Research Project, the ARS should become a full member of the activity.

Basic Research: Where feasible, emphasis should be given to basic research.

Utilization of Different Disciplines: Full advantage should be taken of the benefits of interdisciplinary research with scientists from other disciplines.

Long-range Problems: Special emphasis should be given to research activities which have long-range implications for the continuing success of our national agriculture. For instance, soil compaction investigations would warrant more attention than precision seed placement which has no cumulative effects.

Influence of Environment on Research Personnel: Every effort should be made to insure that research conducted by the Department is of such nature as to have broad implication and that care should be taken to insure that the results are not affected by local bias. It appears that research sometimes becomes oriented to solve purely local problems and the data will not be valid in other areas. The research has much greater potential when it retains the original broad implication.

Farm Electrification Research Center: An adequate facility should be established to provide greater opportunity for research on farm electrification. The versatility of application and control in the use of electric energy offers many possibilities for significant advances in production, processing, and handling agricultural commodities. Control and use systems not yet conceived can contribute much towards greater efficiency in providing for the basic needs of mankind. These systems potentially offer challenges equal to or greater than those involved in space travel. Adequate research facilities should be established to provide opportunities for competent physical scientists to work closely with biological scientists in determining design requirements and basic data needed in this important area. Such facility would yield its greatest return if located so as to provide ready access to scientists in related fields as found at the National Agricultural Research Center or a land-grant college or university with strong schools of engineering and agriculture. The agricultural engineering department should have an active farm electrification interest and offer graduate training. In addition, the program of the national center should provide for keeping abreast of developments in foreign countries with respect to electric power. Results from this area of research are of importance to all segments of the economy since efficiency in handling and processing our food and fiber affects all people.

III. RECOMMENDATIONS ON CURRENT PROGRAM AND NEEDED RESEARCH

In recommending new or expanded research on problems listed in this section, the committee recognizes that it is not its responsibility to delineate between research to be conducted within the Department and that to be conducted in cooperation with State Agricultural Experiment Stations, other research agencies, and industry. The recommendations made by the committee are in terms of the importance of problems on which research is needed and in which the Department should participate.

The recommendations which follow are not arranged in priority order.

A. RURAL HOUSING

Rural Dwellings, Rural Family Housing and Household Operations:

It is recognized that the services of architects may not be readily available to people on farms and small towns in preparing plans for dwellings and there are certain facilities desirable in farm dwellings not normally provided in urban dwellings.

To increase the acceptance and use of farm dwelling standards developed through this research activity, it is recommended that research results be assembled in graphic or other suitable form for dissemination by federal and state agencies as typified by the Extension Service, by rural lending agencies, architects, schools of architecture, building and equipment suppliers, contractors, and rural builders.

B. ECONOMICS OF FARM PRACTICES AND TECHNOLOGY

1. Economics of Building Functions:

Research is needed on feeding operations in which the building facilities are the only variable. This work should be, and in many cases can be, incorporated in regular livestock feeding tests carried out as part of the livestock research program.

2. Economic Evaluation of Practices and Technology:

The economic studies in progress were reviewed and the reduction in scientific manpower and its transfer to other areas was noted. Continuous review should be made of these studies to determine whether they are local, regional or national in scope and character. Every effort should be made to insure that major studies be broad in character. There should be research to determine whether crops such as corn, cotton and wheat follow the so-called law of supply and demand when they are in surplus.

C. IRRIGATION AND DRAINAGE

1. Irrigation:

Irrigation needs to be critically studied to the end that the needs 25 years hence be recognized. Then the research fundamental to the attainment of the 25-year projection should be instituted. Present research projects should be reviewed to determine whether the less important might be dropped and more needed research instituted.

The rapid development of pump irrigation using the groundwater supplies creates the need for information about: (a) The procedure for determining the recharge potential, both natural and artificial, to the end that administration of water rights have some guidance in the issuance of additional rights. (b) Water use efficiency should be studied in all its ramification to the end that the available water might be most effectively used. The use efficiency study should include natural precipitation as well as applied water. And, (c) every effort should be made to establish the laboratory on hydraulics of irrigation structures, referred to in Senate Document No. 59, January 1959, which would include research on evapo-transpiration in its program. If this laboratory is to yield maximum return it must be located to afford opportunity for interdisciplinary research approaches to problems and to extend opportunities for the development of strong, graduate training programs.

2. Drainage:

Drainage, irrigation, and soil moisture studies are all a part of the same problem, namely, the efficient use of available water resources. The combination of irrigation and drainage is especially important in Western agriculture where water quality may be impaired due to salinity and in the reclamation of saline-alkali soils. Irrigation practices in the more humid areas of the United States also create drainage problems that require study.

Basic research is needed on drainage principles involving particularly the flow, seepage, and the movement of water through different soil types. Also, the drainage requirements of crops needs to be studied under controlled conditions of soil, moisture and air temperature, radiation, and humidity. This research can best be pursued in a central laboratory where scientists and engineers of various disciplines can work together.

Research is needed on methods and equipment for purification of both farm well and pond waters with the research correlated with existing research at the state experiment stations.

D. CROP PRODUCTION

1. Soil-machine Relationships:

The work covered in soil-machine relationships is largely that conducted at the U. S. Tillage Laboratory at Auburn. The committee wishes to commend this laboratory for the many contributions which it has made through its existence. The expansion of the laboratory facilities has been noted and it is recommended that the staffing be completed as soon as possible so that an expanded program can be quickly implemented.

The committee agrees with the present and projected programs of the laboratory, with the strong recommendation that the work on "Effect of Tillage Practices on Plant Growth" must be carried on in close cooperation with a plant physiologist if maximum benefit is to be derived.

The committee also noted with much concern the lack of progress in techniques and procedures for providing a quantitative evaluation of the degree of tilth. Although researchers have worked on this problem for many years, the lack of such quantitative measurements has greatly limited progress in the considerable research being conducted in the fields of tillage and seedbed establishment. The committee feels that the ARS is a logical group to make an intensified drive toward accomplishing these objectives.

2. Planting and Fertilizing:

The committee feels that the effort and manpower being devoted to planting and fertilizing operations and equipment by the Agricultural Engineering Research Division is generally sufficient but that some redirection of activities within the area might be appropriate.

We believe that the work on seed and fertilizer placement for small grains has progressed to the point where the most important future activity should be pointed toward gaining a broader public and private research acceptance of the principles.

Although very little effort is planned for transplanting equipment we would raise the question if even this little should be attempted, particularly in view of promising possibilities of direct seeding of such crops.

Rather than doing any work at all on corn planting and fertilizing equipment for Georgia, the committee feels that since basic information on the production of this crop is well understood it would be more useful to concentrate on precision vegetable planting including the uses of various plastic or asphaltic mulches, ehcmicals, or other techniques for direct planting.

The committee also believes that some evaluation should be made of the degree of acceptability of present airplane seeding techniques with the view to understanding the need for future research in this field.

The committee acknowledges the inefficiencies existing under present techniques of establishing dependable stands of cotton and feels that further work in this area is needed. This should be directed toward completely new approaches tied into basic developments of the tillage laboratory rather than refinements of existing practices.

The committee feels that the "permanent bed" concept in cotton culture does represent a very promising basic development and encourages the division to further explore this concept.

There is, also, a continuing need for developing principles relating tillage and planting practices to moisture management and to problems of soil compaction.

3. Crop Pest Control:

Modern pesticides have been one of the primary elements in the technological revolution in agriculture. They are essential for the production of the high quality, clean and healthful agricultural products which the U. S. market demands. Their correct and successful use is possible only with efficient well-designed equipment. With the somewhat meager resources available to them the Crop Pest Control Techniques and Equipment staff of the Crops Production Engineering Research Branch are doing an excellent and essential job. The committee feels their program could be made even stronger by these additions and changes of emphasis.

Drift of pesticides from the area to which they are applied creates many undesirable side effects such as intolerable residues and crop damage. In view of present public concern the entire future of pest control by chemicals may depend upon development of effective and safe means of application. Equipment design could aid in the abatement of this problem and work should be immediately initiated.

Pest control is the heart of quality tree fruit production. The U. S. lags behind all other producing areas of the world by the continuing use of outmoded high volume air blast spray equipment. This equipment is wasteful of power, water, time, and materials. It has been replaced by low volume, high concentration equipment in all other areas. There has been no research by USDA on tree fruit spraying. The equipment is available and has been used in low-growing crops. This should be used for tree fruits, also.

The soil fumigation studies are being carried out with the control of nematodes as the measure of equipment evaluation. Soil fumigation is used to control many other soil-borne pests. The results of the fumigation equipment studies would be more applicable to these other problems if the evaluation of the equipment were made on the basis of the dispersal of the applied substance in the soil.

Strong support is recommended for that portion of the research which is of a basic nature such as the "Physics of Fine Particles" work at the Pioneering Laboratory. Basic work should be expanded to include the development of entirely new methods of pesticide application.

E. HARVESTING FARM PRODUCTS

1. Fruits and Vegetables:

Maximum research effort should be expended on the harvesting of vegetables and fruits to mechanize the operation. The acute shortage of labor for agricultural harvesting is making it imperative that labor-saving devices in the form of harvesting and material handling equipment be developed. Any harvesting requiring large amounts of hand-labor is going to force the producer to leave this particular crop to the cheap-labor countries.

2. Cotton Harvesting Equipment:

Since many of the current cotton harvesting projects are reaching the point at which additional effort will be currently unprofitable, we urge effort be expended in the direction of cooperation with the plant breeder to improve the efficiency of existing methods of mechanical harvesting. Current harvesting equipment can be improved by the field elimination of trash, green bolls, and diseased locks. This work also should be expanded.

3. Forage Harvesting:

Two problems involved in the utilization of forage feeds are moisture content and space requirement for storage. Expanded effort in the direction of moisture removal should be made. Also, density studies should be made to minimize storage space requirement.

4. Long Fiber Crops:

World War II demands for bast fibers justified the effort for this country to grow fibers for cordage uses. The work done has been good but we suggest that there are more important crops that deserve the effort that further work would require.

5. Grain Harvesting Equipment:

An evaluation of current work on grain harvesting and drying should be made to justify the effort now being expended.

6. Oilseeds - Peanut, Potato, Sugarcane, and Tobacco Harvesting:

Work equivalent to the importance of the crop to the total national farm economy should be expended on these products. Success of this program may warrant additional work as the value of the cash crop in an area increases.

F. COTTON GINNING

The decreasing harvesting period is forcing the cotton producers and farmers either collectively or singularly to make a decision. Either the gins or farms must buy increased ginning capacities or find ways of storage which will prevent damage due to weather, trash, or moisture content. A large effort should be expended toward on-farm or at-the-gin storage. At the moment it is impossible for the gins to do quality work without the incoming cotton reaching some equilibrium condition or the gin being forced to exceed the capacity for which it was designed. On-farm cleaning, drying, and storage or the receiving-station type of operation needs research activity.

Information is needed on how long cotton can stay in storage, with how much moisture content, how much trash, etc. What work that has been done has been for a local area but the problem is common to the entire Cotton Belt.

Research on drying should be continued but only on a basic research level. More work is needed on basic fundamentals of moisture transfer. Drying of immature seed-cotton has received little or no attention. Soft seeds are causing seed fragmentation for loss in revenue to the producer, problems to the ginner, and manufacturing problems for the spinner. Existing driers developed by the laboratories are ready for industrial adaptation and require a very minimum of additional effort.

New methods of both long- and short-staple ginning -- basic research -- should be explored. The flight-bar gin has been turned over to the industry for adoption. A minimum of further effort should be expended, but rather exploration of new concepts -- the Batelle Memorial Institute report, for example -- should be of number one interest.

Packaging of cotton has received much attention at the promotional level but little at the research level. Need for new package size, densities, etc., are dictated by the higher labor requirements of the existing bale presses. User education will be required for acceptance of new concepts.

Cooperative effort should be continued with the research breeders and the pilot spinning to establish the significance of many of the on-farm and/or at-the-gin problems.

G. LIVESTOCK ENGINEERING

The basic research now in progress by the ARS in dairy, beef, swine and poultry areas aimed at establishing heat and moisture outputs together with the range of optimum environmental conditions has been of great value to the building industry and the operators of intensive livestock and poultry enterprises. There is need for further dissemination of this information to farmers to assist them in making future plans through the revision of the bulletin series on functional requirements and the publications of the plan services.

Investigation of the correlation of environmental requirements with the human comfort index should be attempted to make these data more easily interpreted and adopted.

H. FARM STRUCTURES

In the general approach to research in the field of farm structures it should be the role of ARS to engage in the basic type of research which will supply the building industry and farmers with criteria needed for proper structures for the various farm enterprises. A portion of the research effort should continue to be aimed at observing trends in changes of crop and livestock management practices. Then research should be initiated to provide design criteria as may be needed when or if these new practices are more generally adopted.

There is also need for the general improvement of quality of farm buildings constructed in line with efforts devoted by the ARS to improve the breeding of crops, livestock, and poultry, and the nutrition of livestock and poultry. Then structures will be able to make a more significant contribution to farmers' net returns in that they can more easily accomplish the management inputs required in the manipulation of nutrition and/or environmental factors.

1. Structures for Crop and Machinery Storage and Plant Growth:

Structures for crop and machinery storage and plant growth are an important part of agriculture in all areas of the United States.

The current research in silage structures indicates investigation of moisture content, density, and control of the atmosphere within the stored product. It is recommended that this effort be shifted toward the basic investigation of these factors in the preservation of high moisture feeds - both forage and grain.

It is recommended that investigation be made of the need for and possibility of preparing design criteria for: (1) dewatering of forage crops and compression of high moisture forages and grains to substantially greater densities and (2) storage of the resulting products in structures providing controlled atmosphere.

Work of the nature of plant growth chambers being basic in nature and cooperative with other disciplines is to be commended.

It is recommended that the adaptation of commercial storage principles for rural home storage of fruit and vegetables be developed as part of the overall civil defense program.

2. Construction Standards, Water Supply, Waste Disposal and Farmstead Planning:

The need is apparent for more reliable data for proper engineering design of farm service buildings. It is recommended that the current study of weather data on snow loads be carried on to conclusion. This should be followed by a similar study of the determination of wind loads of buildings of low profile also using Weather Bureau data.

a. Waste Disposal and Water Supply:

The present rapid trend toward larger scale concentrations of dairy, beef, swine, and poultry enterprises on farms is creating serious problems in temporary storage, handling, and disposal of large quantities of manures and other wastes. There is evidence that some current methods of temporary storage contribute to sanitation problems affecting the health of the animals or poultry and certain methods of disposal lead to contamination of domestic water supplies. Flies, dust and odors also are part of this problem.

Therefore, it is recommended that the current limited research in this area be expanded at once to determine the location and magnitude of the problems, analyze the shortcomings of current practices and to develop criteria for solving the problems.

b. Farmstead and Building Plans:

Farm buildings are rapidly becoming more sophisticated with respect to function. More complex mechanical systems for materials handling, processing, and laborsaving are being incorporated into them.

It is, therefore, recommended that emphasis be shifted from the preparation of detailed construction drawings for specific buildings and using specific building materials to the preparation of systems layouts for various enterprises and criteria for building design such as wall heights, thermal insulation, ventilation, and placement of vapor barriers.

This should also include orientation of buildings, spacing with respect to fire safety, and factors for human safety.

Testing of specific building materials should be limited generally to such tests as might logically be conducted in developing new building construction concepts.

I. FARM ELECTRICITY

1. Electromagnetic and Ultrasonic Energy for Insect Control and Other Farm Uses:

The following comments apply to all the projects relating to insects:

a. The projects are of a very basic nature which should yield data useful to applied research. The research should be continued at a rate compatible with sound research procedure.

b. The findings of laboratory research should not be carried into large-scale field projects until fully warranted by the laboratory results. At that time adequate facility and resources should be provided to fully exploit the potential.

c. The interdisciplinary approach being used is to be commended and every effort should be made to continue the coordination and where possible strengthen it.

The work on electromagnetic seed separation offers important potential. The primary efforts of the research group should be directed to determining the electrostatic constants or other unknown criteria which aid separation for various types of seeds. The development of machines or equipment should generally be done by industry.

2. Electric Equipment for Farm Labor Reduction:

The research on equipment for apiaries is such as to have significance for regional and national programs and therefore should be pushed. The magnitude of the potential sales is not sufficient to justify large expenditures by industry or individual states.

The research on materials handling should stress the development of principles. Such principles will apply to equipment needs for poultry and other livestock. The research on limited feeding in cooperation with the Illinois station offers hope for basic data of value to livestock personnel as well as to engineers and should be continued on an interdisciplinary basis.

3. Electric and Solar Equipment for Environmental Control:

The environmental work in this area is important and primary efforts should be directed to the production of basic design data. The environmental research on poultry should include, if possible, the effects of light quality as well as intensity and variations of light periods.

The research on solar collection should emphasize the development of reliable engineering data for solar collection and problems related to application should be carried only to the point that they contribute to the collection of valuable engineering design data. The investigations on thermoelectric heating and cooling are of interest and may yield valuable design data for the future. Full use of other research group effort is suggested.

4. Farm Electric Service and Research Instrumentation:

The committee regards as of particular significance the development of specialized instrumentation and procedures to the benefit of other research. The research effort on electric demand appears to be at an adequate level. Proposed research on higher farm voltages should be initiated to extend design data to a desirable level. When and if the research research is initiated, every effort should be made to utilize foreign experience and literature to supply as much data as possible.

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